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| Complete List of Authors: | Feehan, Michael; University of Utah College of Pharmacy, Pharmacotherapy; University of Utah College of Pharmacy<br>Morrison, Margaux; University of Utah School of Medicine, Opthalmology & Visual Sciences<br>Tak, Casey; University of Utah College of Pharmacy, Pharmacotherapy<br>Morisky, Donald; UCLA Fielding School of Public Health, Department of Community Health Sciences<br>DeAngelis, M; University of Utah School of Medicine, Opthalmology & Visual Sciences<br>Munger, Mark; University of Utah College of Pharmacy, Pharmacotherapy |
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# Factors Predicting Self-Reported Medication Low Adherence in a Large Sample of Adults in the US General Population

Michael Feehan, Ph.D.,[1,2] Margaux A. Morrison,[2] M.P.H., Casey Tak, B.S.,[1] Donald E. Morisky, Sc.D., M.S.P.H.,[3] Margaret M. DeAngelis, Ph.D.,[2] and Mark A. Munger, Pharm.D.[1]

[1] The Department of Pharmacotherapy, College of Pharmacy, University of Utah, Salt Lake City, UT, USA. [2] The Moran Eye Center, Department of Ophthalmology & Visual Sciences, Moran Eye Centre, University of Utah School of Medicine, Salt Lake City, UT, USA. [3] Department of Community Health Sciences, UCLA Fielding School of Public Health, Los Angeles, CA, USA.

**Corresponding Author:** Dr. Michael Feehan, Department of Pharmacotherapy, College of Pharmacy, L.S. Skaggs Pharmacy Institute, University of Utah, 30 South 2000 East, Salt Lake City, UT 84112, USA; mike.feehan@utah.edu; Tel +1 (801) 581-8054; Fax +1 (801) 587-7923

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**Competing Interests:** None.

**Ethical Standards:** The study protocol and survey instrument were reviewed and considered as exempt based on applicable guidelines involving the ethical treatment of human subjects by the University of Utah Institutional Review Board before the initiation of data collection. The University of Utah Institutional Review Board is fully accredited by the Human Research Protection Programs, Inc.

**Data Sharing:** No extra data available.

## ABSTRACT

**Objectives:** The study objective was to determine the level and correlates of self-reported medication low adherence in the US general population.

**Setting:** A 30-minute cross-sectional online survey was conducted with a national sample of adults.

**Participants:** 9,202 adults (aged 18+) who had filled at least 3 or more prescriptions at a community pharmacy in the past 12 months.

**Primary and secondary outcome measures:** Self-reported medication adherence was measured with the 8-item Morisky Medication Adherence Scale.

**Results:** Low adherence was reported by 42.0%, 29.4% had medium adherence, and 28.6% had high adherence. Low adherence was significantly associated with: lower age (<65 years), being of Hispanic Origin or African-American, having difficulty with healthcare, medication, or transportation costs, needing the support of others to access primary care, health limiting activity, utilizing multiple providers and locations, infrequent visits to primary care providers and visiting an emergency department > 3 times in last 12 months.

**Conclusions:** A very high level of low medication adherence is seen in the general population, particularly for ethnic minorities, those who use multiple healthcare providers and those who experience barriers to access for regular primary care. As clinical, patient education and counselling, and healthcare policy initiatives are directed to tacking the problem of low medication adherence, these should be priority populations for research and interventions.

## ARTICLE SUMMARY

**Strengths and Limitations of This Study:**

- This study addresses a major knowledge gap in that there is a paucity of information on the prevalence and correlates of medication non-adherence across conditions in the general US population.
- In a survey of 9,202 adults from the US general population, a very high level of self-reported low adherence to medications was found (42%).
- Low adherence was predicted by several demographic and healthcare utilization factors including ethnic minority status, infrequent primary care contact and a reliance on emergency medical care.
- A limitation of this study is a reliance on a single, though well validated, measure of self-reported adherence.
- This study provides empirical guidance on priority population targets for clinical, patient education or counselling, and healthcare policy initiatives addressing the problem of low medication adherence, that will ultimately improve community health.

Medication non-adherence is recognized as one of the most important and costly worldwide healthcare problems in the 21st century.[1] The comprehensive 2003 WHO report on adherence to long-term therapies highlighted that: "Increasing the effectiveness of adherence interventions may have a far greater impact on the health of the population than any improvement in specific medical treatments."[2,3] In the United States, an estimated $100-290 billion in preventable costs can be realized by improving the 30-50% adult non-adherence rate to chronic medications.[4] The Congressional budget office (CBO) estimates that a one percent increase in the number of prescriptions filled by beneficiaries would result in a reduction of a fifth of one-percent of total Medicare spending on services.[5]

Adherence is determined by multiple inter-related factors. These include attributes of the patient, the patient's environment (including social supports, characteristics and functioning of the health care system, and the availability and accessibility of health care resources) and characteristics of the disease in question and its treatment.[2] Estimates of the level of medication non-adherence and its correlates in the population can vary dramatically by the way non-adherence or low-adherence is defined, and the data sources used. Primary nonadherence (not picking up a prescription) can range from 7% to 17%,[6-8] and has associated with a variety of patient characteristics including: smoking tobacco, having five or more ambulatory healthcare contacts, ethnicity other than non-Hispanic white, having multiple comorbidities and a shorter time in health plan enrolment.[6] Once patients have picked up an initial prescription, analyses of pharmacy refill data for chronic medications can indicate the level of adherence by tracking whether patients refill their prescriptions according to the designated schedule. In our previous study of a community pharmacy database, using the Medication Possession Ratio (MPR) and Proportion of Days Covered (PDC), we have found rates of *satisfactory adherence* (80% or more

medication availability) for adults in community pharmacy dispensing databases of only 14-16% for asthma, with women and older patients having greater satisfactory adherence.[9] Determining the possible drivers and correlates of low adherence in such databases is challenging given the limited breadth of data available. A more patient-centric way to understand the predictors of low medication adherence is through comparisons of self-reporting medication behavior in association with patients' self-described social, clinical, and environmental factors. As patients tend to self-report higher rates of adherence, any associations between social factors and low adherence then are likely to be conservative. This approach provides healthcare providers with evidence-based factors that should be considered as they evaluate the potential for any one patient to have a lower likelihood of adherence to the regimen recommended.

In order to gauge the level of self-reported medication adherence in the general population, this study surveyed a sample of over 9,000 healthcare consumers. The study was designed to determine the degree of association between a range of potential correlates and self-reported medication low adherence, including age, ethnicity, income level, insurance availability, healthcare utilization, and barriers to healthcare access.

## METHODS

The population-based cross-sectional quantitative study used a 30-minute on-line survey instrument that was approved as exempt following applicable guidelines involving the ethical treatment of human participants by the University of Utah's Institutional Review Board (IRB) before initiating data collection.

## Participants

The sample comprised 10,006 adults (aged 18 years or older) recruited from an established panel of nationally representative consumers who opted-in to be contacted for research purposes. Panelists accessed the survey electronically and received a minimal honorarium for participation. Respondents were pre-screened to meet the inclusion criteria: being an adult aged 18 years or older who had filled at least 3 or more prescriptions at a pharmacy in the past 12 months. Patients with VA, CHAMPUS or TRICARE insurance or who received care through Kaiser, Kaiser Permanente, the Permanente, or the Permanente Medical Group were excluded, given the unique nature of patient management in these systems. Between August 27, 2015 and September 21, 2015, the survey was opened to 15,572 eligible patients. However, the survey was purposely capped, and the survey was closed at 10,006 respondents (64.3% of those eligible). The data set was screened to remove those respondents giving nonsensical data, resulting in a final total of 9,202 surveys for analysis (92.0% of the 10,006).

## Measures

*Medication Adherence:* The NIH Adherence Network expert panel (2011) recommended the use of validated measures to assess adherence.[10] Accordingly, self-reported medication adherence was measured using the 8-item Morisky Medication Adherence Scale (MMAS).[11] This has been validated against other adherence sources such as pharmacy dispensing database fill data,[12] and is accredited/endorsed by the American Medical Association and American Pharmaceutical Association. It has been widely used in adherence research for multiple disease states and medications across numerous countries.[13-16] MMAS-8 scores can range from 0 to 8 with low

adherence defined as a score <6; medium adherence as scores of 6 or <8, and high adherence with a score of 8.

*Demographic Characteristics:* The survey collected individual demographic characteristics including income level and insurance status, perceived level of health, healthcare access and utilization, and perceived barriers to access including the presence or absence of health insurance. Individual age, gender, and ethnicity were collected. Respondent income was categorized by thresholds established by the 2014 US Census Bureau and categorized as poverty, low income, or not poverty or low income.[17-18]

*Health Status:* Respondents rated their perceived general health on a 5-point scale from '1' Poor, '2' Fair, '3' Good, '4' Very Good, and '5' Excellent. The degree to which the respondent's health limited their activities was assessed as: '0' No, Not at All, '1' A Little, or '2' A Lot. Respondents had limited activity due to health if they responded with a 2 for either question, and "Not at All" if they indicated 0 for both questions. All others were classified as health limiting their activities A Little. Health status was further evaluated by counting the number of health conditions respondents were diagnosed with within the past 12 months, including cancer, cardiovascular diseases, endocrine disorders, major mental health conditions; respiratory disorders, allergies or a self-described condition. The resultant comorbidity score ranged from 0 to 16.

*Barriers to Access:* Respondents indicated the degree of difficulty they had in meeting healthcare costs related to primary care, and the costs of prescription medications. They also indicated the degree to which transportation issues made it difficult to access primary care services they needed, as well as the degree to which they needed the support of others at home to get the services they needed. These four items used a 1-to-10 scale where '1' means "Not at all

Difficult" and '10' means "Extremely Difficult." Scores above 7 were used to categorize respondents as 'having difficulty' in each domain.

*Healthcare Utilization:* Respondents indicated how often they visited a primary healthcare provider for services (defined as care for general health issues and prevention, such as illness, physical examinations, vaccinations, and health screenings) in the past 12 months. They also indicted how many different providers they saw in that period. Reliance on emergency or urgent-care was determined by asking what type of healthcare location they received most of their primary care services. They were also asked how often they had visited the emergency room (ER) in the past 12 months to address a personal health issue (not at all, once or twice, or three or more times).

**Statistical Analysis**

Risk factors were tested for their association with low medication adherence defined by a score of <6 on the MMAS-8 adherence scale, using logistic regression models in SAS (v9.3, SAS Institute Inc., Cary, NC, USA). Initial univariate tests were conducted (see Table 2), and those variables significantly associated with low adherence ($p < 0.05$) were then included in a multivariate model.

**RESULTS**

**Respondent characteristics**

A total of 9,202 respondents' surveys were analyzed were analyzed as completed (see Table 1.) Respondents were primarily Caucasian, with those of Hispanic origin, or African-American ethnicity represented by 11.8% and 10.7%, respectively. In terms of age, 18.3% were aged ≥65 years. With regard to income, 14.6% were living below the poverty level and 24.2% had low

income. Respondents were well represented from the four regions of the United States, with a somewhat higher proportion in the South (38.5%) than in the Northeast (19.1%), Midwest (24.7%) or the West (17.6%). Most answered they lived in a small city/town (31.3%) or suburb of a large city (34.8%).

**Table 1** Demographic characteristics of 9,202 adults surveyed from the general population.

| Characteristic | Total N= 9,202 | | Male N= 4,226 (45.9%) | | Female N= 4,976 (54.1%) | |
|---|---|---|---|---|---|---|
| | No. | (%) | No. | (%) | No. | (%) |
| Age | | | | | | |
| Age 65+ | 1,688 | (18.3) | 830 | (19.6) | 858 | (17.2) |
| 18-64 | 7,514 | (81.7) | 3,396 | (80.4) | 4,118 | (82.8) |
| Hispanic Origin | | | | | | |
| Hispanic Origin | 1,088 | (11.8) | 569 | (13.5) | 519 | (10.4) |
| Non-Hispanic Origin | 8,114 | (88.2) | 3,657 | (86.5) | 4,457 | (89.6) |
| Race | | | | | | |
| African American | 985 | (10.7) | 453 | (10.7) | 532 | (10.7) |
| Non-African American | 8,217 | (89.3) | 3,773 | (89.3) | 4,444 | (89.3) |
| Insurance Status | | | | | | |
| Insured | 8,701 | (94.6) | 4,008 | (94.8) | 4,693 | (94.3) |
| Non-Insured | 501 | (5.4) | 218 | (5.2) | 283 | (5.7) |
| Poverty Level | | | | | | |
| Poverty | 1,346 | (14.6) | 447 | (10.6) | 899 | (18.1) |
| Low Income | 2,229 | (24.2) | 916 | (21.7) | 1,313 | (26.4) |
| Above Low Income | 5,627 | (61.1) | 2,863 | (67.7) | 2,764 | (55.5) |
| Community Residence | | | | | | |
| Rural | 1,748 | (19.0) | 690 | (16.3) | 1,058 | (21.3) |
| Small City or Town | 2,879 | (31.3) | 1,311 | (31.0) | 1,568 | (31.5) |
| Suburb of a Large City | 3,203 | (34.8) | 1,525 | (36.1) | 1,678 | (33.7) |
| Large City | 1,372 | (14.9) | 700 | (16.6) | 672 | (13.5) |
| Region | | | | | | |
| Northeast | 1,759 | (19.1) | 838 | (19.8) | 921 | (18.5) |
| Midwest | 2,273 | (24.7) | 1,025 | (24.3) | 1,248 | (25.1) |
| South | 3,546 | (38.5) | 1,560 | (36.9) | 1,986 | (39.9) |
| West | 1,624 | (17.6) | 803 | (19.0) | 821 | (16.5) |

**Low medication adherence and its correlates**

Using the standard cutoffs for the Morisky scale, 3,862 (42%) respondents had 'low' self-reported adherence (<6 on the scale), 2,706 (29.4%) had 'medium' adherence (6 or <8 on the scale) and 2,635 (28.6) had 'high' adherence (score of 8).

Table 2 shows the degree of association between each of the demographic and predictor variables with low adherence in the univariate analyses. Univariate predictors of low adherence ranked by highest to lowest strength of association included age < 65 years (OR: 2.96), frequent visits to the emergency department (OR: 2.52 [3 or more]) or care mostly delivered through a hospital or urgent care facility (OR: 1.62), difficulty with transportation for healthcare needs (OR: 2.01), health status (OR: 1.93 [poor]; 1.69 [fair]; 1.36 [good]; and 1.12 [very good]), needs support of others (OR: 1.92), difficulty with healthcare and medication costs (OR: 1.76), Hispanic and African-American ethnicity (OR: 1.63; 1.41), poverty or low income (OR 1.61; 1.38), visit to primary care doctor every 2 years (AOR: 1.51), utilization of more than 2 providers or more than 2 locations (OR: 1.48, 1.43), and women (OR: 1.17).

Table 2 also shows the results from the multivariate model. Low adherence was most strongly associated with being aged less than 65 years (AOR: 2.39), Hispanic origin (AOR = 1.45) or African-American (AOR: 1.40), difficulty with healthcare, medication, or transportation costs (AORs: 1.21, 1.23, 1.37, respectively), needing support of others (AOR: 1.16), health limiting activity(AOR: 1.23), utilizing more than 2 providers (AOR: 1.27), utilizing more than two locations for primary care healthcare services (AOR: 1.14), visiting a primary care provider every few years (AOR 2.18), and visiting an emergency department > 3 times in last 12 months (AOR: 1.52).

**Table 2** Univariate and multivariate associations between multiple predictor variables and self-reported low medication adherence as measured by the 8-item MMAS* in 9,202 adults surveyed from the general population.

| | | Univariate Results | | Multivariate Results | |
|---|---|---|---|---|---|
| **Risk Factors** | ***n* (% total)** | **Odds Ratio (95% CI)** | ***p* value** | **Adjusted Odds Ratio (AOR) (95% CI)** | ***p* value** |
| **Age:** | | | | | |
| Age < 65 | 7514 (81.7) | 2.959 (2.617-3.346) | <0.0001 | 2.389 (2.09-2.729) | <0.0001 |
| Age 65+ (ref) | 1688 (18.3) | | | | |
| **Ethnicity:** | | | | | |
| Hispanic | 1088 (11.8) | 1.630 (1.438-1.854) | <0.0001 | 1.453 (1.251-1.688) | <0.0001 |
| Non-Hispanic (ref) | 8114 (88.2) | | | | |
| Black/African American | 928 (10.7) | 1.413 (1.232-1.619) | <0.0001 | 1.398 (1.208-1.619) | <0.0001 |
| White (ref) | 7771 (89.3) | | | | |
| **Gender:** | | | | | |
| Female | 4976 (54.1) | 1.174 (1.080-1.276) | 0.0002 | 1.141 (1.039-1.254) | 0.0057 |
| Male (ref) | 4226 (45.9) | | | | |
| **Income and Insurance:** | | | | | |
| Low income | 2229 (24.2) | 1.378 (1.248-1.522) | 0.1164 | - | - |

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|---|---|---|---|---|---|
| Poverty | 1346 (14.6) | 1.612 (1.431-1.817) | <0.0001 | - | - |
| Neither poverty or low income (ref) | 5627 (61.2) | | | | |
| No health insurance | 501 (5.4) | 1.502 (1.254-1.799) | <0.0001 | - | - |
| Health insurance (ref) | 8701 (94.6) | | | | |
| **Barriers to Access:** | | | | | |
| Has Difficulty with Healthcare Costs | 3963 (43.1) | 1.760 (1.618-1.914) | <0.0001 | 1.209 (1.079-1.356) | 0.0011 |
| No Difficulty (ref) | 5239 (56.9) | | | | |
| Has Difficulty with Medication Cost | 4289 (46.6) | 1.761 (1.620-1.915) | <0.0001 | 1.227 (1.093-1.377) | 0.0005 |
| No Difficulty (ref) | 4913 (53.4) | | | | |
| Has Difficulty with Transportation to Medical Care | 3835 (41.7) | 2.073 (1.904-2.256) | <0.0001 | 1.365 (1.217-1.53) | <0.0001 |
| No Difficulty (ref) | 5367 (58.3) | | | | |
| Needs Support of Others | 4338 (47.1) | 1.916 (1.762-2.084) | <0.0001 | 1.158 (1.034-1.298) | 0.0114 |
| Does Not Need Support (ref) | 4864 (52.9) | | | | |
| **Health Status:** | | | | | |
| Poor health | 489 (5.3) | 1.929 (1.449-2.568) | <0.0001 | - | - |
| Fair health | 2167 (23.6) | 1.688 (1.328-2.146) | <0.0001 | - | - |
| Good health | 3930 (42.7) | 1.359 (1.076-1.716) | 0.7323 | - | - |
| Very good health | 2279 (24.8) | 1.123 (0.883-1.428) | <0.0001 | - | - |

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|---|---|---|---|---|---|
| Excellent health (ref) | 337 (3.7) | | | | |
| Health limiting activity a little bit | 2718 (29.5) | 1.447 (1.314-1.592) | <0.0001 | 1.232 (1.098-1.382) | 0.0004 |
| Health limiting activity a lot | 1836 (20.0) | 1.421 (1.274-1.585) | 0.0016 | - | - |
| Health not limiting (ref) | 4648 (50.5) | | | | |
| Number of Comorbidities | $\bar{x}$ = 2.7, SD = 2.1 | 1.058 (1.037-1.080) | <0.0001 | - | - |
| **Healthcare Utilization:** | | | | | |
| Utilized More than 2 Providers | 4254 (46.2) | 1.483 (1.364-1.611) | <0.0001 | 1.274 (1.146-1.416) | <0.0001 |
| ≤ 2 Providers (ref) | 4948 (53.8) | | | | |
| Utilized More than 2 Locations for Primary Healthcare Services | 2317 (25.2) | 1.434 (1.319-1.558) | <0.0001 | 1.142 (1.012-1.289) | 0.0310 |
| ≤ 2 Locations (ref) | 6885 (74.8) | | | | |
| Visits PCP Every Few Years | 217 (2.4) | 1.514 (1.121-2.044) | <0.0001 | 2.184 (1.545-3.087) | <0.0001 |
| Visits PCP Once a Year | 1670 (18.4) | 0.770 (0.656-0.904) | 0.0318 | - | - |
| Visits PCP Every 6 Months | 2770 (30.5) | 0.558 (0.480-0.648) | <0.0001 | 0.92 (0.773-1.095) | <0.0001 |
| Visits PCP Every 2-5 Months | 3481 (38.4) | 0.719 (0.623-0.831) | <0.0001 | 0.92 (0.783-1.081) | <0.0001 |
| Every month (ref) | 937 (10.3) | | | | |
| Receive Most Care in Hospital/Urgent Care | 579 (6.4) | 1.615 (1.364-1.912) | <0.0001 | - | - |
| Other locations (ref) | 8528 (93.6) | | | | |

| | | | | | |
|---|---|---|---|---|---|
| Visited ED 1-2 Times in Last 12 Months | 2509 (27.3) | 1.497 (1.363-1.644) | 0.3380 | - | - |
| Visited ED 3 or More Times in Last 12 Months | 541 (5.9) | 2.519 (2.104-3.016) | <0.0001 | 1.524 (1.226-1.895) | 0.0004 |
| No visits (ref) | 6152 (66.9) | | | | |
| **Geography:** | | | | | |
| Live in Large City | 1372 (14.9) | 1.048 (0.908-1.209) | 0.2946 | - | - |
| Live in Suburb of a Large City | 3203 (34.8) | 0.900 (0.800-1.014) | 0.0020 | - | - |
| Live in Small City or Town | 2879 (31.3) | 1.061 (0.941-1.196) | 0.0915 | - | - |
| Rural (ref) | 1748 (19.0) | | | | |
| | | | | | |
| Live in Midwest | 2273 (24.7) | 1.035 (0.912-1.174) | 0.7050 | - | - |
| Live in South | 3546 (38.5) | 1.075 (0.957-1.208) | 0.4545 | - | - |
| Live in West | 1624 (17.7) | 1.090 (0.950-1.249) | 0.3661 | - | - |
| Northeast (ref) | 1759 (19.1) | | | | |

**Abbreviations:** *n*, number; CI, confidence interval; ref, referent; $\bar{x}$, mean; SD, standard deviation, PCP, Primary Care Provider; ED, Emergency department.

## DISCUSSION

The level of self-reported low medication adherence in this large sample of healthcare consumers from the general population, using a well-recognized standardized instrument, of 42% is alarmingly high. It is somewhat lower than the 52.7% seen with the same measure in an inner-city sample, which was associated with younger age.[19] Similarly, lower age was the strongest predictor of low adherence in our study, followed by socioeconomic status as it relates specifically to the ability to afford healthcare costs, frequent use of emergency room or urgent care centers for healthcare, and use of more providers and locations were associated with lower adherence rates. High adherence rates were associated with having a frequent ongoing relationship with a primary care provider.

A limitation of the study is its cross sectional nature. A prospective longitudinal study of a large general population sample, would allow for a determination of associated adverse health outcomes from low adherence over time. A potential source of bias is that those who are less adherent, may be less likely to participate in online e survey's. This would suggest that the level of low adherence reported in the study may be an underestimate. Further, this is a comprehensive evaluation of the US population, and its application to other countries warrants further study.

One of the larger studies of low adherence in the U.S. is the Cohort Study of Medication Adherence among Older Adults (CoSMO), an investigation of antihypertensive medication adherence among 2,194 adults aged 65 years and older recruited from a managed care organization in Louisiana.[20] In this study, 14.1% of respondents self-reported reported low medication adherence using the Morisky Medication Adherence Scale (MMAS 8-item version).[11] Factors associated with low adherence included being younger (less than 75 years of age), being African-American, having a higher body mass index (BMI).[20] In a subsequent study

of this cohort, a decline in adherence was predictive by the presence of depressive symptoms, being female, being married, and the level of stressful life events experienced.[21] Our rate of 42% is 3-fold higher than the CoSMO study, however, shorter enrolment time in healthcare plans is associated with higher levels of non-adherence.[6] Our higher rate may also be accounted for by the wider range of patients (i.e., not restricted to those with a singly condition) and the wider age distributions compared to the CoSMO sample. As noted in the CoSMO study, even among an older sample, younger age was associated with low adherence.[20] We found that age < 65 years was the strongest independent factor associated with of low-adherence in the present study, consistent with previous studies showing higher adherence with increasing age.[9] Age may also be related to more commonly having a continuous relationship with a provider, something that is not always seen with younger healthy individuals.

Low-adherence was observed uniformly across the country, without differentiation to geographic region, size of community, and respondents' health status and level of comorbidities. However, beyond age, certain demographic characteristics stand out as being significantly independently associated with low adherence, notably being of Hispanic origin or African-American. This is after adjusting for income and other access and healthcare utilization factors. A recent study of income data for the US population from 1999-2004 showed that higher income was associated with greater longevity over time and differences in life expectancy were correlated with rates of smoking, obesity and positively correlated with exercise rates.[22] Furthermore, medical causes such as heart disease and cancer mortality are known to be higher in in individuals with lower socioeconomic status when compared to vehicle crashes, suicide and homicide. Could a lack of a consistent relationship with a provider, the inability to afford health costs or ease of being able to access healthcare and poor medication adherence lead to greater

mortality from heart disease and cancer? Further exploration is warranted to determine the drivers of low adherence in these populations, so perhaps to be able to improve health outcomes in lower socioeconomic areas.

Although respondents' health status *per se* was not independently associated with low-adherence in our multivariate model, importantly the level of healthcare utilization was. Low-adherence was significantly and independently associated with use of multiple healthcare providers and locations, and a high level of emergency room use. In thus study it is not possible to tease out temporal causality, and it may be that these factors may be a consequence of low adherence, but also possible predictors, as the use of multiple providers may foster the possibility of miscommunications in health education and counselling, particularly with regard to medication use. Development of a centralized electronic medical record, independent of healthcare systems, that allows all providers a link to the same information source, could assist in improving the quality of healthcare delivery by reducing harms, improving communication between providers, thereby improving medication adherence.

In the present multivariate model, low-adherence is a phenomenon observed uniformly across the country, with no statistically significant differentiation with regard to geographic region, size of community, and respondents' health status and level of comorbidities. However, beyond age, certain demographic characteristics stand out as being significantly independently associated with low adherence, notably being of Hispanic origin or African-American. This is after adjusting for income and other access and healthcare utilization factors. Further research is warranted to determine the drivers of low adherence in these populations. Again, it may be that the quality and delivery processes for health education and counselling with regard to mediations may be deficit for ethnic minority patients.

## CONCLUSIONS

This study demonstrated a very high level of self-reported low medication adherence in the general population, reinforcing the WHO report of non-adherence as a significant public health problem. It is particularly evident that after adjusting for income and insurance, medication adherence remains a significant issue for ethnic minorities, those who use multiple healthcare providers, and those who experience barriers to healthcare access in term of the ability to pay for healthcare and medications, transportation issues, and a need of reliance on others. Patient education, counselling, and healthcare policy initiatives directed to addressing low medication adherence, should be priorities for research and interventions. One such step could be to focus healthcare resources towards how to engage patients in a meaningful, continuous, and quality patient-provider relationship, that is medication adherence-centric.

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**STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cross-sectional studies***

| Section/Topic | Item # | Recommendation | Reported on page # |
|---|---|---|---|
| **Title and abstract** | 1 | (*a*) Indicate the study's design with a commonly used term in the title or the abstract | 3, abstract |
| | | (*b*) Provide in the abstract an informative and balanced summary of what was done and what was found | 3 |
| **Introduction** | | | |
| Background/rationale | 2 | Explain the scientific background and rationale for the investigation being reported | 5-6 |
| Objectives | 3 | State specific objectives, including any prespecified hypotheses | 6 |
| **Methods** | | | |
| Study design | 4 | Present key elements of study design early in the paper | 6 |
| Setting | 5 | Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection | 7 |
| Participants | 6 | (*a*) Give the eligibility criteria, and the sources and methods of selection of participants | 7 |
| Variables | 7 | Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable | 7-9 |
| Data sources/ measurement | 8* | For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group | 7-9 |
| Bias | 9 | Describe any efforts to address potential sources of bias | 17 |
| Study size | 10 | Explain how the study size was arrived at | 7 |
| Quantitative variables | 11 | Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why | 7-9 |
| Statistical methods | 12 | (*a*) Describe all statistical methods, including those used to control for confounding | 9,12 |
| | | (*b*) Describe any methods used to examine subgroups and interactions | 12 |
| | | (*c*) Explain how missing data were addressed | n/a no missing data |
| | | (*d*) If applicable, describe analytical methods taking account of sampling strategy | n/a |
| | | (*e*) Describe any sensitivity analyses | n/a |
| **Results** | | | |

| | | | |
|---|---|---|---|
| Participants | 13* | (a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed | 7 |
| | | (b) Give reasons for non-participation at each stage | n/a |
| | | (c) Consider use of a flow diagram | n/a |
| Descriptive data | 14* | (a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders | 11 |
| | | (b) Indicate number of participants with missing data for each variable of interest | n/a no missing data |
| Outcome data | 15* | Report numbers of outcome events or summary measures | 12 |
| Main results | 16 | (*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included | 12 |
| | | (*b*) Report category boundaries when continuous variables were categorized | n/a |
| | | (*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period | n/a |
| Other analyses | 17 | Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses | 12-16 |
| **Discussion** | | | |
| Key results | 18 | Summarise key results with reference to study objectives | 17 |
| Limitations | 19 | Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias | 17 |
| Interpretation | 20 | Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence | 20 |
| Generalisability | 21 | Discuss the generalisability (external validity) of the study results | 17 |
| **Other information** | | | |
| Funding | 22 | Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based | 1-2 |

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

**Note:** An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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# Factors Predicting Self-Reported Medication Low Adherence in a Large Sample of Adults in the US General Population

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# Factors Predicting Self-Reported Medication Low Adherence in a Large Sample of Adults in the US General Population

Michael Feehan, Ph.D.,[1,2] Margaux A. Morrison,[2] M.P.H., Casey Tak, B.S.,[1] Donald E. Morisky, Sc.D., M.S.P.H.,[3] Margaret M. DeAngelis, Ph.D.,[2] and Mark A. Munger, Pharm.D.[1]

[1] The Department of Pharmacotherapy, College of Pharmacy, University of Utah, Salt Lake City, UT, USA. [2] The Moran Eye Center, Department of Ophthalmology & Visual Sciences, Moran Eye Centre, University of Utah School of Medicine, Salt Lake City, UT, USA. [3] Department of Community Health Sciences, UCLA Fielding School of Public Health, Los Angeles, CA, USA.

**Corresponding Author:** Dr. Michael Feehan, Department of Pharmacotherapy, College of Pharmacy, L.S. Skaggs Pharmacy Institute, University of Utah, 30 South 2000 East, Salt Lake City, UT 84112, USA; mike.feehan@utah.edu; Tel +1 (801) 581-8054; Fax +1 (801) 587-7923

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**Competing Interests:** None.

**Ethical Standards:** The study protocol and survey instrument were reviewed and considered as exempt based on applicable guidelines involving the ethical treatment of human subjects by the University of Utah Institutional Review Board before the initiation of data collection. The University of Utah Institutional Review Board is fully accredited by the Human Research Protection Programs, Inc.

**Data Sharing:** No extra data available.

## ABSTRACT

**Objectives:** The study objective was to determine the level and correlates of self-reported medication low adherence in the US general population.

**Setting:** A 30-minute cross-sectional online survey was conducted with a national sample of adults.

**Participants:** 9,202 adults (aged 18+) who had filled at least 3 or more prescriptions at a community pharmacy in the past 12 months.

**Primary and secondary outcome measures:** Self-reported medication adherence was measured with the 8-item Morisky Medication Adherence Scale.

**Results:** Low adherence was reported by 42.0%, 29.4% had medium adherence, and 28.6% had high adherence. Low adherence was significantly associated with: lower age, being of Hispanic Origin or African-American, having difficulty with healthcare, medication, or transportation costs, needing the support of others to access primary care, health limiting activity, utilizing multiple providers, infrequent visits to primary care providers and visiting an emergency department > 3 times in last 12 months.

**Conclusions:** A very high level of low medication adherence is seen in the general population, particularly for ethnic minorities, those who use multiple healthcare providers and those who experience barriers to access for regular primary care. As clinical, patient education and counselling, and healthcare policy initiatives are directed to tacking the problem of low medication adherence, these should be priority populations for research and interventions.

## ARTICLE SUMMARY

**Strengths and Limitations of This Study:**

- This study addresses a major knowledge gap in that there is a paucity of information on the prevalence and correlates of self-reported medication non-adherence across conditions in the general US population.
- In a survey of 9,202 adults from the US general population, a very high level of self-reported low adherence to medications was found (42%).
- Low adherence was predicted by several demographic and healthcare utilization factors including ethnic minority status, infrequent primary care contact and a reliance on emergency medical care.
- A limitation of this study is a reliance on a single, though well validated, measure of self-reported adherence.
- This study provides empirical guidance on priority population targets for clinical, patient education or counselling, and healthcare policy initiatives addressing the problem of low medication adherence, that will ultimately improve community health.

Medication non-adherence is recognized as one of the most important and costly worldwide healthcare problems in the 21st century.[1] The comprehensive 2003 WHO report on adherence to long-term therapies highlighted that: "Increasing the effectiveness of adherence interventions may have a far greater impact on the health of the population than any improvement in specific medical treatments."[2,3] In the United States, an estimated $100-290 billion in preventable costs can be realized by improving the estimated 30-50% adult non-adherence rate to chronic medications.[4] The Congressional budget office (CBO) estimates that a one percent increase in the number of prescriptions filled by beneficiaries would result in a reduction of a fifth of one-percent of total Medicare spending on services.[5] The literature on the prevalence of non-adherence is challenging in that estimates vary widely by countries, the methodologies employed (e.g., database abstraction from claims databases versus self-report through surveys), and the criteria used to define of low adherence. There is a paucity of information on the overall prevalence and correlates of medication non-adherence as reported by patients themselves (across ethnic and socioeconomic groups), across conditions in the general US population.

Adherence is determined by multiple inter-related factors. These include attributes of the patient, the patient's environment (including social supports, characteristics and functioning of the health care system, and the availability and accessibility of health care resources) and characteristics of the disease in question and its treatment.[2] Estimates of the level of medication non-adherence and its correlates in the population can vary dramatically by the way non-adherence or low-adherence is defined, and the data sources used. Primary nonadherence (not picking up a prescription) can range from 7% to 17%,[6-8] and has been associated with a variety of patient characteristics (adjusted odds ratios up to 1.76) including: smoking tobacco, having five or more ambulatory healthcare contacts, ethnicity other than non-Hispanic white, having

multiple comorbidities and a shorter time in health plan enrolment.[6] Once patients have picked up an initial prescription, analyses of pharmacy refill data for chronic medications can indicate the level of adherence by tracking whether patients refill their prescriptions according to the designated schedule. In our previous studies of community pharmacy databases, using the Medication Possession Ratio (MPR) and Proportion of Days Covered (PDC), we have found rates of *satisfactory adherence* (80% or more medication availability) for adults in community pharmacy dispensing databases of only 14-16% for asthma, with women and older patients having greater satisfactory adherence;[9,] and in an older sample, only 30-37% for eye-drop medications for glaucoma – a blinding disease.[10] Determining the possible drivers and correlates of low adherence in such databases is challenging given the limited breadth of data available. A more patient-centric way to understand the predictors of low medication adherence is through comparisons of self-reporting medication behavior in association with patients' self-described social, clinical, and environmental factors. As patients tend to self-report higher rates of adherence, any associations between social factors and low adherence then are likely to be conservative. This approach provides healthcare providers with evidence-based factors that should be considered as they evaluate the potential for any one patient to have a lower likelihood of adherence to the regimen recommended.

In order to gauge the level of self-reported medication adherence in the general population, this study surveyed a sample of over 9,000 healthcare consumers. The study was designed to determine the degree of association between a range of potential correlates and self-reported medication low adherence, including age, ethnicity, income level, insurance availability, healthcare utilization, and barriers to healthcare access.

## METHODS

The population-based cross-sectional quantitative study used a 30-minute on-line survey instrument (English language only), that was approved as exempt following applicable guidelines involving the ethical treatment of human participants by the University of Utah's Institutional Review Board (IRB) before initiating data collection.

### Participants

The sample comprised 10,006 adults (aged 18 years or older) recruited from an established nationally representative panel of individuals in the USA, who opted-in to be contacted for research purposes (Universal Survey Center, Inc., d/b/a SHC Universal New York, NY). Panelists accessed the survey electronically through an invitation email, and received a minimal honorarium for participation. Respondents were pre-screened to meet the inclusion criteria: being an adult aged 18 years or older who had filled at least 3 or more prescriptions at a pharmacy in the past 12 months (no information on specific disease states the prescriptions were for, or the actual medications, was gathered). Patients with VA, CHAMPUS or TRICARE insurance or who received care through Kaiser, Kaiser Permanente, the Permanente, or the Permanente Medical Group were excluded, given the unique nature of patient management in these systems. Between August 27, 2015 and September 21, 2015, the survey was opened to 15,572 eligible patients. However, the survey was purposely capped, and the survey was closed at 10,006 respondents (64.3% of those eligible). The data set was screened to remove those respondents giving nonsensical data (i.e., not providing variation in answers, completing the survey in unrealistically short time, giving manifestly inconsistent responses), resulting in a final total of 9,202 surveys for analysis (92.0% of the 10,006).

## Measures

*Medication Adherence:* The NIH Adherence Network expert panel (2011) recommended the use of validated measures to assess adherence.[11] Accordingly, self-reported medication adherence was measured using the 8-item Morisky Medication Adherence Scale (MMAS).[12] This has been validated against other adherence sources such as pharmacy dispensing database fill data,[13] and is accredited/endorsed by the American Medical Association and American Pharmaceutical Association. It has been widely used in adherence research for multiple disease states and medications across numerous countries.[14-16] In this study the MMAS-8 was used to assess for self-reported low adherence in general, and was not grounded in any specific conditions or medications. MMAS-8 scores can range from 0 to 8 with low adherence defined as a score <6; medium adherence as scores of 6 or <8, and high adherence with a score of 8.

*Demographic Characteristics:* The survey collected individual demographic characteristics including income level and insurance status, perceived level of health, healthcare access and utilization, and perceived barriers to access including the presence or absence of health insurance. Individual age, gender, and ethnicity were collected. Respondent income was categorized by thresholds established by the 2014 US Census Bureau and categorized as poverty, low income, or not poverty or low income.[18-19]

*Health Status:* Respondents rated their perceived general health on a 5-point scale from '1' Poor, '2' Fair, '3' Good, '4' Very Good, and '5' Excellent. The degree to which the respondent's health limited their activities was assessed as: '0' No, Not at All, '1' A Little, or '2' A Lot. Respondents had limited activity due to health if they responded with a 2 for either question, and "Not at All" if they indicated 0 for both questions. All others were classified as

health limiting their activities A Little. Health status was further evaluated by counting the number of health conditions respondents were diagnosed with within the past 12 months, including cancer, cardiovascular diseases, endocrine disorders, major mental health conditions; respiratory disorders, allergies or a self-described condition. The resultant comorbidity score ranged from 0 to 16.

*Barriers to Access:* Respondents indicated the degree of difficulty they had in meeting healthcare costs related to primary care, and the costs of prescription medications. They also indicated the degree to which transportation issues made it difficult to access primary care services they needed, as well as the degree to which they needed the support of others at home to get the services they needed. These four items used a 1-to-10 scale where '1' means "Not at all Difficult" and '10' means "Extremely Difficult." Scores above 7 were used to categorize respondents as 'having difficulty' in each domain.

*Healthcare Utilization:* Respondents indicated how often they visited a primary healthcare provider for services (defined as care for general health issues and prevention, such as illness, physical examinations, vaccinations, and health screenings) in the past 12 months. They also indicted how many different providers they saw in that period. Reliance on emergency or urgent-care was determined by asking what type of healthcare location they received most of their primary care services. They were also asked how often they had visited the emergency room (ER) in the past 12 months to address a personal health issue (not at all, once or twice, or three or more times).

The survey also included an experimental task evaluating perceptions of operational factors and services offered by community pharmacies (unrelated to adherence), to be reported elsewhere.

### Statistical Analysis

Risk factors were tested for their association with low medication adherence defined by a score of <6 on the MMAS-8 adherence scale, using binary logistic regression models in SAS (v9.3, SAS Institute Inc., Cary, NC, USA). Initial univariate tests were conducted (see Table 2), and those variables significantly associated with low adherence ($p < 0.05$) were then included in a multivariate model. Given the large sample size and the number of univariate tests being conducted, to avoid spurious associations this conservative approach was used rather than using a looser inclusion criterion ($p < 0.20$). No issues with multicollinearity between predictor variables were thus observed.

## RESULTS

### Respondent characteristics

A total of 9,202 respondents' surveys were analyzed were analyzed as completed (see Table 1.) Respondents were primarily Caucasian, with those of Hispanic origin, or African-American ethnicity represented by 11.8% and 10.7%, respectively. In terms of age, 18.3% were aged ≥65 years with the majority of respondents being aged 46-64 years. The youngest age group aged 18-25 years was the smallest (6.0%), presumably more healthy which is consistent with the study screening for prior prescription filling at a pharmacy. With regard to income, 14.6% were living below the poverty level and 24.2% had low income. Respondents were well represented from the four regions of the United States, with a somewhat higher proportion in the South (38.5%) than in the Northeast (19.1%), Midwest (24.7%) or the West (17.6%). Most answered they lived in a small city/town (31.3%) or suburb of a large city (34.8%).

**Table 1** Demographic characteristics of 9,202 adults surveyed from the general population.

| Characteristic | Total N= 9,202 | | Male N= 4,226 (45.9%) | | Female N= 4,976 (54.1%) | |
|---|---|---|---|---|---|---|
| | No. | (%) | No. | (%) | No. | (%) |
| Age | | | | | | |
| 18-25 | 553 | (6.0) | 277 | (6.6) | 276 | (5.6) |
| 26-45 | 2,843 | (30.9) | 1,294 | (30.62) | 1,549 | (31.1) |
| 46-64 | 4,118 | (44.8) | 1,825 | (43.2) | 2,293 | (44.8) |
| 65+ | 1,688 | (18.3) | 830 | (19.6) | 858 | (17.2) |
| Hispanic Origin | | | | | | |
| Hispanic Origin | 1,088 | (11.8) | 569 | (13.5) | 519 | (10.4) |
| Non-Hispanic Origin | 8,114 | (88.2) | 3,657 | (86.5) | 4,457 | (89.6) |
| Race | | | | | | |
| African American | 985 | (10.7) | 453 | (10.7) | 532 | (10.7) |
| Non-African American | 8,217 | (89.3) | 3,773 | (89.3) | 4,444 | (89.3) |
| Insurance Status | | | | | | |
| Insured | 8,701 | (94.6) | 4,008 | (94.8) | 4,693 | (94.3) |
| Non-Insured | 501 | (5.4) | 218 | (5.2) | 283 | (5.7) |
| Poverty Level | | | | | | |
| Poverty | 1,346 | (14.6) | 447 | (10.6) | 899 | (18.1) |
| Low Income | 2,229 | (24.2) | 916 | (21.7) | 1,313 | (26.4) |
| Above Low Income | 5,627 | (61.1) | 2,863 | (67.7) | 2,764 | (55.5) |
| Community Residence | | | | | | |
| Rural | 1,748 | (19.0) | 690 | (16.3) | 1,058 | (21.3) |
| Small City or Town | 2,879 | (31.3) | 1,311 | (31.0) | 1,568 | (31.5) |
| Suburb of a Large City | 3,203 | (34.8) | 1,525 | (36.1) | 1,678 | (33.7) |
| Large City | 1,372 | (14.9) | 700 | (16.6) | 672 | (13.5) |
| Region | | | | | | |
| Northeast | 1,759 | (19.1) | 838 | (19.8) | 921 | (18.5) |
| Midwest | 2,273 | (24.7) | 1,025 | (24.3) | 1,248 | (25.1) |
| South | 3,546 | (38.5) | 1,560 | (36.9) | 1,986 | (39.9) |
| West | 1,624 | (17.6) | 803 | (19.0) | 821 | (16.5) |

**Low medication adherence and its correlates**

Using the standard cutoffs for the Morisky scale, 3,862 (42%) respondents had 'low' self-reported adherence (<6 on the scale), 2,706 (29.4%) had 'medium' adherence (6 or <8 on the scale) and 2,635 (28.6) had 'high' adherence (score of 8).

Table 2 shows the degree of association between each of the demographic and predictor variables with low adherence in the univariate analyses. Univariate predictors of low adherence ranked by highest to lowest strength of association included age, adherence lowest in the youngest age group and improving with each age category, frequent visits to the emergency department (OR: 2.52 [3 or more]) or care mostly delivered through a hospital or urgent care facility (OR: 1.62), difficulty with transportation for healthcare needs (OR: 2.01), health status (OR: 1.93 [poor]; 1.69 [fair]; 1.36 [good]; and 1.12 [very good]), needs support of others (OR: 1.92), difficulty with healthcare and medication costs (OR: 1.76), Hispanic and African-American ethnicity (OR: 1.63; 1.41), poverty or low income (OR 1.61; 1.38), visit to primary care doctor every 2 years (AOR: 1.51), utilization of more than 2 providers or more than 2 locations (OR: 1.48, 1.43), and women (OR: 1.17).

Table 2 also shows the results from the multivariate model. This model was a well-fitting model with a C-statistic of 0.7.[20] Low adherence was most strongly associated with being of younger age; Hispanic origin (AOR = 1.24) or African-American (AOR: 1.42), difficulty with healthcare, medication, or transportation costs (AORs: 1.24, 1.24, 1.32, respectively, health limiting activity (AOR: 1.33), utilizing more than 2 providers (AOR: 1.27), visiting a primary

care provider every few years (AOR 2.06), and visiting an emergency department > 3 times in last 12 months (AOR: 1.34).

**Table 2** Univariate and multivariate associations between multiple predictor variables and self-reported low medication adherence as measured by the 8-item MMAS* in 9,202 adults surveyed from the general population.

| | | Univariate Results | | Multivariate Results | |
|---|---|---|---|---|---|
| **Risk Factors** | ***n* (% total)** | **Odds Ratio (95% CI)** | ***p* value** | **Adjusted Odds Ratio (AOR) (95% CI)** | ***p* value** |
| **Age:** | | | | | |
| Age 65+ | 1688 (24.2) | 0.158 (0.128-0.194) | <0.0001 | 0.174 (0.138-0.221) | <0.0001 |
| Age 46-64 | 4118 (44.8) | 0.330 (0.274-0.397) | <0.0001 | 0.313 (0.245-0.386) | <0.0001 |
| Age 26-45 | 2843 (30.9) | 0.658 (0.544-0.795) | <0.0001 | 0.632 (0.513-0.780) | <0.0001 |
| Age 18-25 (ref) | 553 (6.0) | | | | |
| **Ethnicity:** | | | | | |
| Hispanic | 1088 (11.8) | 1.630 (1.438-1.854) | <0.0001 | 1.237 (1.060-1.444) | <0.0068 |
| Non-Hispanic (ref) | 8114 (88.2) | | | | |
| Black/African American | 928 (10.7) | 1.413 (1.232-1.619) | <0.0001 | 1.423 (1.227-1.651) | <0.0001 |
| White (ref) | 7771 (89.3) | | | | |
| **Gender:** | | | | | |
| Female | 4976 (54.1) | 1.174 (1.080-1.276) | 0.0002 | 1.136 (1.033-1.249) | 0.0088 |
| Male (ref) | 4226 (45.9) | | | | |

| | | | | | |
|---|---|---|---|---|---|
| **Income and Insurance:** | | | | | |
| Low income | 2229 (24.2) | 1.378 (1.248-1.522) | 0.1164 | - | - |
| Poverty | 1346 (14.6) | 1.612 (1.431-1.817) | <0.0001 | - | - |
| Neither poverty or low income (ref) | 5627 (61.2) | | | | |
| No health insurance | 501 (5.4) | 1.502 (1.254-1.799) | <0.0001 | - | - |
| Health insurance (ref) | 8701 (94.6) | | | | |
| **Barriers to Access:** | | | | | |
| Has Difficulty with Healthcare Costs | 3963 (43.1) | 1.760 (1.618-1.914) | <0.0001 | 1.239 (1.104-1.391) | 0.0003 |
| No Difficulty (ref) | 5239 (56.9) | | | | |
| Has Difficulty with Medication Cost | 4289 (46.6) | 1.761 (1.620-1.915) | <0.0001 | 1.240 (1.103-1.394) | 0.0003 |
| No Difficulty (ref) | 4913 (53.4) | | | | |
| Has Difficulty with Transportation to Medical Care | 3835 (41.7) | 2.073 (1.904-2.256) | <0.0001 | 1.321 (1.176-1.483) | <0.0001 |
| No Difficulty (ref) | 5367 (58.3) | | | | |
| Needs Support of Others | 4338 (47.1) | 1.916 (1.762-2.084) | <0.0001 | - | - |
| Does Not Need Support (ref) | 4864 (52.9) | | | | |
| **Health Status:** | | | | | |
| Poor health | 489 (5.3) | 1.929 (1.449-2.568) | <0.0001 | - | - |
| Fair health | 2167 (23.6) | 1.688 (1.328-2.146) | <0.0001 | 1.594 (1.199-2.119) | 0.0069 |

| | | | | | |
|---|---|---|---|---|---|
| Good health | 3930 (42.7) | 1.359 (1.076-1.716) | 0.7323 | - | - |
| Very good health | 2279 (24.8) | 1.123 (0.883-1.428) | <0.0001 | - | - |
| Excellent health (ref) | 337 (3.7) | | | | |
| Health limiting activity a little bit | 2718 (29.5) | 1.447 (1.314-1.592) | <0.0001 | 1.333 (1.185-1.498) | 0.0003 |
| Health limiting activity a lot | 1836 (20.0) | 1.421 (1.274-1.585) | 0.0016 | - | - |
| Health not limiting (ref) | 4648 (50.5) | | | | |
| Number of Comorbidities | $\bar{x}$ = 2.7, SD = 2.1 | 1.058 (1.037-1.080) | <0.0001 | - | - |
| **Healthcare Utilization:** | | | | | |
| Utilized More than 2 Providers | 4254 (46.2) | 1.483 (1.364-1.611) | <0.0001 | 1.270 (1.141-1.413) | <0.0001 |
| ≤ 2 Providers (ref) | 4948 (53.8) | | | | |
| Utilized More than 2 Locations for Primary Healthcare Services | 2317 (25.2) | 1.434 (1.319-1.558) | <0.0001 | - | - |
| ≤ 2 Locations (ref) | 6885 (74.8) | | | | |
| Visits PCP Every Few Years | 217 (2.4) | 1.514 (1.121-2.044) | <0.0001 | 2.057 (1.445-2.927) | <0.0001 |
| Visits PCP Once a Year | 1670 (18.4) | 0.770 (0.656-0.904) | 0.0318 | - | - |
| Visits PCP Every 6 Months | 2770 (30.5) | 0.558 (0.480-0.648) | <0.0001 | 0.917 (0.769-1.094) | <0.0001 |
| Visits PCP Every 2-5 Months | 3481 (38.4) | 0.719 (0.623-0.831) | <0.0001 | 0.928 (0.788-1.092) | <0.0001 |
| Every month (ref) | 937 (10.3) | | | | |

| | | | | | |
|---|---|---|---|---|---|
| Receive Most Care in Hospital/Urgent Care | 579 (6.4) | 1.615 (1.364-1.912) | <0.0001 | - | - |
| Other locations (ref) | 8528 (93.6) | | | | |
| Visited ED 1-2 Times in Last 12 Months | 2509 (27.3) | 1.497 (1.363-1.644) | 0.3380 | - | - |
| Visited ED 3 or More Times in Last 12 Months | 541 (5.9) | 2.519 (2.104-3.016) | <0.0001 | 1.339 (1.073-1.672) | 0.0107 |
| No visits (ref) | 6152 (66.9) | | | | |
| **Geography:** | | | | | |
| Live in Large City | 1372 (14.9) | 1.048 (0.908-1.209) | 0.2946 | - | - |
| Live in Suburb of a Large City | 3203 (34.8) | 0.900 (0.800-1.014) | 0.0020 | - | - |
| Live in Small City or Town | 2879 (31.3) | 1.061 (0.941-1.196) | 0.0915 | - | - |
| Rural (ref) | 1748 (19.0) | | | | |
| Live in Midwest | 2273 (24.7) | 1.035 (0.912-1.174) | 0.7050 | - | - |
| Live in South | 3546 (38.5) | 1.075 (0.957-1.208) | 0.4545 | - | - |
| Live in West | 1624 (17.7) | 1.090 (0.950-1.249) | 0.3661 | - | - |
| Northeast (ref) | 1759 (19.1) | | | | |

**Abbreviations:** *n*, number; CI, confidence interval; ref, referent; $\bar{x}$, mean; SD, standard deviation, PCP, Primary Care Provider; ED, Emergency department.

## DISCUSSION

The level of self-reported low medication adherence in this large sample of healthcare consumers from the general population, using a well-recognized standardized instrument, of 42% is alarmingly high, and is probably an underestimate. It is somewhat lower than the 52.7% seen with the same measure in an inner-city sample, which was associated with younger age.[21] Similarly, lower age was the strongest predictor of low adherence in our study, followed by socioeconomic status as it relates specifically to the ability to afford healthcare costs, frequent use of emergency room or urgent care centers for healthcare, and use of more providers - all associated with lower adherence rates. High adherence rates were associated with having a frequent ongoing relationship with a primary care provider.

A limitation of the study is its cross sectional nature. A prospective longitudinal study of a large general population sample, would allow for a determination of associated adverse health outcomes from low adherence over time. Some limitations of the study may suggest the low adherence estimates obtained may be an underestimate: A potential source of bias is that those who are less adherent, may be less likely to participate in online survey's. The study is focused on adherence in general, rather than specific conditions or medications. Since it is possible for a person to indicate adherence to one medication whilst being non-adherent to another, and reporting themselves as overall adherent, this could also suggest the present already very high estimates on low adherence may underestimate the true level of low adherence. The survey was administered in English language only, a Spanish language version may elicit more reporting of low-adherence for the Hispanic respondents. One additional limitation of the study was the restriction on survey length, which limited the ability to explore adherence by specific disorders,

and a deeper exploration of the patient's health status. Further, this is a comprehensive evaluation of the US population, and its application to other countries warrants further study.

One of the larger studies of low adherence in the U.S. is the Cohort Study of Medication Adherence among Older Adults (CoSMO), an investigation of antihypertensive medication adherence among 2,194 adults aged 65 years and older recruited from a managed care organization in Louisiana.[22] In this study, 14.1% of respondents self-reported reported low medication adherence using the Morisky Medication Adherence Scale (MMAS 8-item version).[12] Factors associated with low adherence included being younger (less than 75 years of age), being African-American, having a higher body mass index (BMI).[22] In a subsequent study of this cohort, a decline in adherence was predictive by the presence of depressive symptoms, being female, being married, and the level of stressful life events experienced.[23] Our rate of 42% is 3-fold higher than the CoSMO study, however, shorter enrolment time in healthcare plans is associated with higher levels of non-adherence.[6] Our higher rate may also be accounted for by the wider range of patients (i.e., not restricted to those with a singly condition) and the wider age distributions compared to the CoSMO sample. As noted in the CoSMO study, even among an older sample, younger age was associated with low adherence.[22] We found that younger age was the strongest independent factor associated with of low-adherence in the present study, consistent with our previous studies showing higher adherence with increasing age.[9,10] Age may also be related to more commonly having a continuous relationship with a provider, something that is not always seen with younger healthy individuals.

Low-adherence was observed uniformly across the country, without differentiation to geographic region, size of community, and respondents' health status and level of comorbidities. However, beyond age, certain demographic characteristics stand out as being significantly

independently associated with low adherence, notably being of Hispanic origin or African-American. This is after adjusting for income and other access and healthcare utilization factors. A recent study of income data for the US population from 1999-2004 showed that higher income was associated with greater longevity over time and differences in life expectancy were correlated with rates of smoking, obesity and positively correlated with exercise rates.[24] Furthermore, medical causes such as heart disease and cancer mortality are known to be higher in in individuals with lower socioeconomic status when compared to vehicle crashes, suicide and homicide. Could a lack of a consistent relationship with a provider, the inability to afford health costs or ease of being able to access healthcare and poor medication adherence lead to greater mortality from heart disease and cancer? Further exploration is warranted to determine the drivers of low adherence in these populations, so perhaps to be able to improve health outcomes in lower socioeconomic areas.

Although respondents' health status *per se* was not independently associated with low-adherence in our multivariate model, importantly the level of healthcare utilization was. Low-adherence was significantly and independently associated a high level of emergency room use. In this study it is not possible to tease out temporal causality, and it may be that these factors may be a consequence of low adherence, but also possible predictors, as the use of multiple providers may foster the possibility of miscommunications in health education and counselling, particularly with regard to medication use. Development of a centralized electronic medical record, independent of healthcare systems, that allows all providers a link to the same information source, could assist in improving the quality of healthcare delivery by reducing harms, improving communication between providers, thereby improving medication adherence.

In the present multivariate model, low-adherence is a phenomenon observed uniformly across the country, with no statistically significant differentiation with regard to geographic region, size of community, and respondents' health status and level of comorbidities. However, beyond age, certain demographic characteristics stand out as being significantly independently associated with low adherence, notably being of Hispanic origin or African-American. This is after adjusting for income and other access and healthcare utilization factors. Further research is warranted to determine the drivers of low adherence in these populations. Again, it may be that the quality and delivery processes for health education and counselling with regard to mediations may be deficit for ethnic minority patients.

## CONCLUSIONS

This study demonstrated a very high level of self-reported low medication adherence in the general population, reinforcing the WHO report of non-adherence as a significant public health problem. It is particularly evident that after adjusting for income and insurance status, medication adherence remains a significant issue for ethnic minorities, those who use multiple healthcare providers, and those who experience barriers to healthcare access in term of the ability to pay for healthcare and medications, and transportation issues. Patient education, counselling, and healthcare policy initiatives directed to addressing low medication adherence, should be priorities for research and interventions. One such step could be to focus healthcare resources towards how to engage patients in a meaningful, continuous, and quality patient-provider relationship, that is medication adherence-centric.

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**STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cross-sectional studies***

| Section/Topic | Item # | Recommendation | Reported on page # |
|---|---|---|---|
| **Title and abstract** | 1 | (*a*) Indicate the study's design with a commonly used term in the title or the abstract | 3, abstract |
| | | (*b*) Provide in the abstract an informative and balanced summary of what was done and what was found | 3 |
| **Introduction** | | | |
| Background/rationale | 2 | Explain the scientific background and rationale for the investigation being reported | 5-6 |
| Objectives | 3 | State specific objectives, including any prespecified hypotheses | 6 |
| **Methods** | | | |
| Study design | 4 | Present key elements of study design early in the paper | 6 |
| Setting | 5 | Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection | 7 |
| Participants | 6 | (*a*) Give the eligibility criteria, and the sources and methods of selection of participants | 7 |
| Variables | 7 | Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable | 7-9 |
| Data sources/ measurement | 8* | For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group | 7-9 |
| Bias | 9 | Describe any efforts to address potential sources of bias | 17 |
| Study size | 10 | Explain how the study size was arrived at | 7 |
| Quantitative variables | 11 | Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why | 7-9 |
| Statistical methods | 12 | (*a*) Describe all statistical methods, including those used to control for confounding | 9,12 |
| | | (*b*) Describe any methods used to examine subgroups and interactions | 12 |
| | | (*c*) Explain how missing data were addressed | n/a no missing data |
| | | (*d*) If applicable, describe analytical methods taking account of sampling strategy | n/a |
| | | (*e*) Describe any sensitivity analyses | n/a |
| **Results** | | | |

| | | | |
|---|---|---|---|
| Participants | 13* | (a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed | 7 |
| | | (b) Give reasons for non-participation at each stage | n/a |
| | | (c) Consider use of a flow diagram | n/a |
| Descriptive data | 14* | (a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders | 11 |
| | | (b) Indicate number of participants with missing data for each variable of interest | n/a no missing data |
| Outcome data | 15* | Report numbers of outcome events or summary measures | 12 |
| Main results | 16 | (*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included | 12 |
| | | (*b*) Report category boundaries when continuous variables were categorized | n/a |
| | | (*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period | n/a |
| Other analyses | 17 | Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses | 12-16 |
| **Discussion** | | | |
| Key results | 18 | Summarise key results with reference to study objectives | 17 |
| Limitations | 19 | Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias | 17 |
| Interpretation | 20 | Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence | 20 |
| Generalisability | 21 | Discuss the generalisability (external validity) of the study results | 17 |
| **Other information** | | | |
| Funding | 22 | Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based | 1-2 |

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

**Note:** An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

BMJ Open

# Factors Predicting Self-Reported Medication Low Adherence in a Large Sample of Adults in the US General Population: A Cross-sectional Study



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# Factors Predicting Self-Reported Medication Low Adherence in a Large Sample of Adults in the US General Population: A Cross-sectional Study

Michael Feehan, Ph.D.,[1,2] Margaux A. Morrison,[2] M.P.H., Casey Tak, B.S.,[1] Donald E. Morisky, Sc.D., M.S.P.H.,[3] Margaret M. DeAngelis, Ph.D.,[2] and Mark A. Munger, Pharm.D.[1]

[1] The Department of Pharmacotherapy, College of Pharmacy, University of Utah, Salt Lake City, UT, USA. [2] The Moran Eye Center, Department of Ophthalmology & Visual Sciences, Moran Eye Centre, University of Utah School of Medicine, Salt Lake City, UT, USA. [3] Department of Community Health Sciences, UCLA Fielding School of Public Health, Los Angeles, CA, USA.

**Corresponding Author:** Dr. Michael Feehan, Department of Pharmacotherapy, College of Pharmacy, L.S. Skaggs Pharmacy Institute, University of Utah, 30 South 2000 East, Salt Lake City, UT 84112, USA; mike.feehan@utah.edu; Tel +1 (801) 581-8054; Fax +1 (801) 587-7923

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**Contribution of each author:** Dr.'s Feehan and Munger had full access to all the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis. Study concept and design: Feehan, DeAngelis, Morisky, Munger. Acquisition, analysis or interpretation of data: All authors. Drafting of the manuscript: Feehan. Critical revision of the manuscript for important intellectual content: All authors. Statistical analysis: Morrison, Tak. Obtaining funding: Feehan, DeAngelis, Munger. Study supervision: Feehan, Munger. All authors approved the manuscript.

**Competing Interests:** None.

**Ethical Standards:** The study protocol and survey instrument were reviewed and considered as exempt based on applicable guidelines involving the ethical treatment of human subjects by the University of Utah Institutional Review Board before the initiation of data collection. The University of Utah Institutional Review Board is fully accredited by the Human Research Protection Programs, Inc.

**Data Sharing:** No extra data available.

## ABSTRACT

**Objectives:** The study objective was to determine the level and correlates of self-reported medication low adherence in the US general population.

**Setting:** A 30-minute cross-sectional online survey was conducted with a national sample of adults.

**Participants:** 9,202 adults (aged 18+) who had filled at least 3 or more prescriptions at a community pharmacy in the past 12 months.

**Primary and secondary outcome measures:** Self-reported medication adherence was measured with the 8-item Morisky Medication Adherence Scale.

**Results:** Low adherence was reported by 42.0%, 29.4% had medium adherence, and 28.6% had high adherence. Low adherence was significantly associated with: lower age, being of Hispanic Origin or African-American, having difficulty with healthcare, medication, or transportation costs, needing the support of others to access primary care, health limiting activity, utilizing multiple providers, infrequent visits to primary care providers and visiting an emergency department > 3 times in last 12 months.

**Conclusions:** A very high level of low medication adherence is seen in the general population, particularly for ethnic minorities, those who use multiple healthcare providers and those who experience barriers to access for regular primary care. As clinical, patient education and counselling, and healthcare policy initiatives are directed to tacking the problem of low medication adherence, these should be priority populations for research and interventions.

## ARTICLE SUMMARY

**Strengths and Limitations of This Study:**

- This study addresses a major knowledge gap in that there is a paucity of information on the prevalence and correlates of self-reported medication non-adherence across conditions in the general US population.
- In a survey of 9,202 adults from the US general population, a very high level of self-reported low adherence to medications was found (42%).
- Low adherence was predicted by several demographic and healthcare utilization factors including ethnic minority status, infrequent primary care contact and a reliance on emergency medical care.
- A limitation of this study is a reliance on a single, though well validated, measure of self-reported adherence.
- This study provides empirical guidance on priority population targets for clinical, patient education or counselling, and healthcare policy initiatives addressing the problem of low medication adherence, that will ultimately improve community health.

Medication non-adherence is recognized as one of the most important and costly worldwide healthcare problems in the 21st century.[1] The comprehensive 2003 WHO report on adherence to long-term therapies highlighted that: "Increasing the effectiveness of adherence interventions may have a far greater impact on the health of the population than any improvement in specific medical treatments."[2,3] In the United States, an estimated $100-290 billion in preventable costs can be realized by improving the estimated 30-50% adult non-adherence rate to chronic medications.[4] The Congressional budget office (CBO) estimates that a one percent increase in the number of prescriptions filled by beneficiaries would result in a reduction of a fifth of one-percent of total Medicare spending on services.[5] The literature on the prevalence of non-adherence is challenging in that estimates vary widely by countries, the methodologies employed (e.g., database abstraction from claims databases versus self-report through surveys), and the criteria used to define of low adherence. There is a paucity of information on the overall prevalence and correlates of medication non-adherence as reported by patients themselves (across ethnic and socioeconomic groups), across conditions in the general US population.

Adherence is determined by multiple inter-related factors. These include attributes of the patient, the patient's environment (including social supports, characteristics and functioning of the health care system, and the availability and accessibility of health care resources) and characteristics of the disease in question and its treatment.[2] Estimates of the level of medication non-adherence and its correlates in the population can vary dramatically by the way non-adherence or low-adherence is defined, and the data sources used. Primary nonadherence (not picking up a prescription) can range from 7% to 17%,[6-8] and has been associated with a variety of patient characteristics (adjusted odds ratios up to 1.76) including: smoking tobacco, having five or more ambulatory healthcare contacts, ethnicity other than non-Hispanic white, having

multiple comorbidities and a shorter time in health plan enrolment.[6] Once patients have picked up an initial prescription, analyses of pharmacy refill data for chronic medications can indicate the level of adherence by tracking whether patients refill their prescriptions according to the designated schedule. In our previous studies of community pharmacy databases, using the Medication Possession Ratio (MPR) and Proportion of Days Covered (PDC), we have found rates of *satisfactory adherence* (80% or more medication availability) for adults in community pharmacy dispensing databases of only 14-16% for asthma, with women and older patients having greater satisfactory adherence;[9,] and in an older sample, only 30-37% for eye-drop medications for glaucoma – a blinding disease.[10] Determining the possible drivers and correlates of low adherence in such databases is challenging given the limited breadth of data available. A more patient-centric way to understand the predictors of low medication adherence is through comparisons of self-reporting medication behavior in association with patients' self-described social, clinical, and environmental factors. As patients tend to self-report higher rates of adherence, any associations between social factors and low adherence then are likely to be conservative. This approach provides healthcare providers with evidence-based factors that should be considered as they evaluate the potential for any one patient to have a lower likelihood of adherence to the regimen recommended.

In order to gauge the level of self-reported medication adherence in the general population, this study surveyed a sample of over 9,000 healthcare consumers. The study was designed to determine the degree of association between a range of potential correlates and self-reported medication low adherence, including age, ethnicity, income level, insurance availability, healthcare utilization, and barriers to healthcare access.

## METHODS

The population-based cross-sectional quantitative study used a 30-minute on-line survey instrument (English language only), that was approved as exempt following applicable guidelines involving the ethical treatment of human participants by the University of Utah's Institutional Review Board (IRB) before initiating data collection.

### Participants

The sample comprised 10,006 adults (aged 18 years or older) recruited from an established nationally representative panel of individuals in the USA, who opted-in to be contacted for research purposes (Universal Survey Center, Inc., d/b/a SHC Universal New York, NY). Panelists accessed the survey electronically through an invitation email, and received a minimal honorarium for participation. Respondents were pre-screened to meet the inclusion criteria: being an adult aged 18 years or older who had filled at least 3 or more prescriptions at a pharmacy in the past 12 months (no information on specific disease states the prescriptions were for, or the actual medications, was gathered). Patients with VA, CHAMPUS or TRICARE insurance or who received care through Kaiser, Kaiser Permanente, the Permanente, or the Permanente Medical Group were excluded, given the unique nature of patient management in these systems. Between August 27, 2015 and September 21, 2015, the survey was opened to 15,572 eligible patients. However, the survey was purposely capped, and the survey was closed at 10,006 respondents (64.3% of those eligible). The data set was screened to remove those respondents giving nonsensical data (i.e., not providing variation in answers, completing the survey in unrealistically short time, giving manifestly inconsistent responses), resulting in a final total of 9,202 surveys for analysis (92.0% of the 10,006).

## Measures

*Medication Adherence:* The NIH Adherence Network expert panel (2011) recommended the use of validated measures to assess adherence.[11] Accordingly, self-reported medication adherence was measured using the 8-item Morisky Medication Adherence Scale (MMAS).[12] This has been validated against other adherence sources such as pharmacy dispensing database fill data,[13] and is accredited/endorsed by the American Medical Association and American Pharmaceutical Association. It has been widely used in adherence research for multiple disease states and medications across numerous countries.[14-17] In this study the MMAS-8 was used to assess for self-reported low adherence in general, and was not grounded in any specific conditions or medications. MMAS-8 scores can range from 0 to 8 with low adherence defined as a score <6; medium adherence as scores of 6 or <8, and high adherence with a score of 8.

*Demographic Characteristics:* The survey collected individual demographic characteristics including income level and insurance status, perceived level of health, healthcare access and utilization, and perceived barriers to access including the presence or absence of health insurance. Individual age, gender, and ethnicity were collected. Respondent income was categorized by thresholds established by the 2014 US Census Bureau and categorized as poverty, low income, or not poverty or low income.[18-19]

*Health Status:* Respondents rated their perceived general health on a 5-point scale from '1' Poor, '2' Fair, '3' Good, '4' Very Good, and '5' Excellent. The degree to which the respondent's health limited their activities was assessed as: '0' No, Not at All, '1' A Little, or '2' A Lot. Respondents had limited activity due to health if they responded with a 2 for either question, and "Not at All" if they indicated 0 for both questions. All others were classified as

health limiting their activities A Little. Health status was further evaluated by counting the number of health conditions respondents were diagnosed with within the past 12 months, including cancer, cardiovascular diseases, endocrine disorders, major mental health conditions; respiratory disorders, allergies or a self-described condition. The resultant comorbidity score ranged from 0 to 16.

*Barriers to Access:* Respondents indicated the degree of difficulty they had in meeting healthcare costs related to primary care, and the costs of prescription medications. They also indicated the degree to which transportation issues made it difficult to access primary care services they needed, as well as the degree to which they needed the support of others at home to get the services they needed. These four items used a 1-to-10 scale where '1' means "Not at all Difficult" and '10' means "Extremely Difficult." Scores above 7 were used to categorize respondents as 'having difficulty' in each domain.

*Healthcare Utilization:* Respondents indicated how often they visited a primary healthcare provider for services (defined as care for general health issues and prevention, such as illness, physical examinations, vaccinations, and health screenings) in the past 12 months. They also indicted how many different providers they saw in that period. Reliance on emergency or urgent-care was determined by asking what type of healthcare location they received most of their primary care services. They were also asked how often they had visited the emergency room (ER) in the past 12 months to address a personal health issue (not at all, once or twice, or three or more times).

The survey also included an experimental task evaluating perceptions of operational factors and services offered by community pharmacies (unrelated to adherence), to be reported elsewhere.

### Statistical Analysis

Risk factors were tested for their association with low medication adherence defined by a score of <6 on the MMAS-8 adherence scale, using binary logistic regression models in SAS (v9.3, SAS Institute Inc., Cary, NC, USA). Initial univariate tests were conducted and those variables significantly associated with low adherence ($p < 0.05$) were then included in a multivariate model. Given the large sample size and the number of univariate tests being conducted, to avoid spurious associations this conservative approach was used rather than using a looser inclusion criterion ($p < 0.20$). No issues with multicollinearity between predictor variables were thus observed.

## RESULTS

### Respondent characteristics

A total of 9,202 respondents' surveys were analyzed were analyzed as completed (see Table 1.) Respondents were primarily Caucasian, with those of Hispanic origin, or African-American ethnicity represented by 11.8% and 10.7%, respectively. In terms of age, 18.3% were aged ≥65 years with the majority of respondents being aged 46-64 years. The youngest age group aged 18-25 years was the smallest (6.0%), presumably more healthy which is consistent with the study screening for prior prescription filling at a pharmacy. With regard to income, 14.6% were living below the poverty level and 24.2% had low income. Respondents were well represented from the four regions of the United States, with a somewhat higher proportion in the South (38.5%) than in the Northeast (19.1%), Midwest (24.7%) or the West (17.6%). Most answered they lived in a small city/town (31.3%) or suburb of a large city (34.8%).

**Table 1** Demographic characteristics of 9,202 adults surveyed from the general population.

| Characteristic | Total N= 9,202 | | Male N= 4,226 (45.9%) | | Female N= 4,976 (54.1%) | |
|---|---|---|---|---|---|---|
| | No. | (%) | No. | (%) | No. | (%) |
| Age | | | | | | |
| 18-25 | 553 | (6.0) | 277 | (6.6) | 276 | (5.6) |
| 26-45 | 2,843 | (30.9) | 1,294 | (30.62) | 1,549 | (31.1) |
| 46-64 | 4,118 | (44.8) | 1,825 | (43.2) | 2,293 | (44.8) |
| 65+ | 1,688 | (18.3) | 830 | (19.6) | 858 | (17.2) |
| Hispanic Origin | | | | | | |
| Hispanic Origin | 1,088 | (11.8) | 569 | (13.5) | 519 | (10.4) |
| Non-Hispanic Origin | 8,114 | (88.2) | 3,657 | (86.5) | 4,457 | (89.6) |
| Race | | | | | | |
| African American | 985 | (10.7) | 453 | (10.7) | 532 | (10.7) |
| Non-African American | 8,217 | (89.3) | 3,773 | (89.3) | 4,444 | (89.3) |
| Insurance Status | | | | | | |
| Insured | 8,701 | (94.6) | 4,008 | (94.8) | 4,693 | (94.3) |
| Non-Insured | 501 | (5.4) | 218 | (5.2) | 283 | (5.7) |
| Poverty Level | | | | | | |
| Poverty | 1,346 | (14.6) | 447 | (10.6) | 899 | (18.1) |
| Low Income | 2,229 | (24.2) | 916 | (21.7) | 1,313 | (26.4) |
| Above Low Income | 5,627 | (61.1) | 2,863 | (67.7) | 2,764 | (55.5) |
| Community Residence | | | | | | |
| Rural | 1,748 | (19.0) | 690 | (16.3) | 1,058 | (21.3) |
| Small City or Town | 2,879 | (31.3) | 1,311 | (31.0) | 1,568 | (31.5) |
| Suburb of a Large City | 3,203 | (34.8) | 1,525 | (36.1) | 1,678 | (33.7) |
| Large City | 1,372 | (14.9) | 700 | (16.6) | 672 | (13.5) |
| Region | | | | | | |
| Northeast | 1,759 | (19.1) | 838 | (19.8) | 921 | (18.5) |
| Midwest | 2,273 | (24.7) | 1,025 | (24.3) | 1,248 | (25.1) |
| South | 3,546 | (38.5) | 1,560 | (36.9) | 1,986 | (39.9) |
| West | 1,624 | (17.6) | 803 | (19.0) | 821 | (16.5) |

**Low medication adherence and its correlates**

Using the standard cutoffs for the Morisky scale, 3,862 (42%) respondents had 'low' self-reported adherence (<6 on the scale), 2,706 (29.4%) had 'medium' adherence (6 or <8 on the scale) and 2,635 (28.6) had 'high' adherence (score of 8).

Table 2 shows the degree of association between each of the demographic and predictor variables with low adherence in the univariate analyses. Univariate predictors of low adherence ranked by highest to lowest strength of association included age, adherence lowest in the youngest age group and improving with each age category, frequent visits to the emergency department (OR: 2.52 [3 or more]) or care mostly delivered through a hospital or urgent care facility (OR: 1.62), difficulty with transportation for healthcare needs (OR: 2.01), health status (OR: 1.93 [poor]; 1.69 [fair]; 1.36 [good]; and 1.12 [very good]), needs support of others (OR: 1.92), difficulty with healthcare and medication costs (OR: 1.76), Hispanic and African-American ethnicity (OR: 1.63; 1.41), poverty or low income (OR 1.61; 1.38), visit to primary care doctor every 2 years (AOR: 1.51), utilization of more than 2 providers or more than 2 locations (OR: 1.48, 1.43), and women (OR: 1.17).

Table 2 also shows the results from the multivariate model. This model was a well-fitting model with a C-statistic of 0.7.[20] Low adherence was most strongly associated with being of younger age; Hispanic origin (AOR = 1.24) or African-American (AOR: 1.42), difficulty with healthcare, medication, or transportation costs (AORs: 1.24, 1.24, 1.32, respectively, health limiting activity (AOR: 1.33), utilizing more than 2 providers (AOR: 1.27), visiting a primary

care provider every few years (AOR 2.06), and visiting an emergency department > 3 times in last 12 months (AOR: 1.34).

**Table 2** Univariate and multivariate associations between multiple predictor variables and self-reported low medication adherence as measured by the 8-item MMAS* in 9,202 adults surveyed from the general population.

| | | Univariate Results | | Multivariate Results | |
|---|---|---|---|---|---|
| **Risk Factors** | ***n* (% total)** | **Odds Ratio (95% CI)** | ***p* value** | **Adjusted Odds Ratio (AOR) (95% CI)** | ***p* value** |
| **Age:** | | | | | |
| Age 65+ | 1688 (24.2) | 0.158 (0.128-0.194) | <0.0001 | 0.174 (0.138-0.221) | <0.0001 |
| Age 46-64 | 4118 (44.8) | 0.330 (0.274-0.397) | <0.0001 | 0.313 (0.245-0.386) | <0.0001 |
| Age 26-45 | 2843 (30.9) | 0.658 (0.544-0.795) | <0.0001 | 0.632 (0.513-0.780) | <0.0001 |
| Age 18-25 (ref) | 553 (6.0) | | | | |
| **Ethnicity:** | | | | | |
| Hispanic | 1088 (11.8) | 1.630 (1.438-1.854) | <0.0001 | 1.237 (1.060-1.444) | <0.0068 |
| Non-Hispanic (ref) | 8114 (88.2) | | | | |
| Black/African American | 928 (10.7) | 1.413 (1.232-1.619) | <0.0001 | 1.423 (1.227-1.651) | <0.0001 |
| White (ref) | 7771 (89.3) | | | | |
| **Gender:** | | | | | |
| Female | 4976 (54.1) | 1.174 (1.080-1.276) | 0.0002 | 1.136 (1.033-1.249) | 0.0088 |
| Male (ref) | 4226 (45.9) | | | | |

| | | | | | |
|---|---|---|---|---|---|
| **Income and Insurance:** | | | | | |
| Low income | 2229 (24.2) | 1.378 (1.248-1.522) | 0.1164 | - | - |
| Poverty | 1346 (14.6) | 1.612 (1.431-1.817) | <0.0001 | - | - |
| Neither poverty or low income (ref) | 5627 (61.2) | | | | |
| No health insurance | 501 (5.4) | 1.502 (1.254-1.799) | <0.0001 | - | - |
| Health insurance (ref) | 8701 (94.6) | | | | |
| **Barriers to Access:** | | | | | |
| Has Difficulty with Healthcare Costs | 3963 (43.1) | 1.760 (1.618-1.914) | <0.0001 | 1.239 (1.104-1.391) | 0.0003 |
| No Difficulty (ref) | 5239 (56.9) | | | | |
| Has Difficulty with Medication Cost | 4289 (46.6) | 1.761 (1.620-1.915) | <0.0001 | 1.240 (1.103-1.394) | 0.0003 |
| No Difficulty (ref) | 4913 (53.4) | | | | |
| Has Difficulty with Transportation to Medical Care | 3835 (41.7) | 2.073 (1.904-2.256) | <0.0001 | 1.321 (1.176-1.483) | <0.0001 |
| No Difficulty (ref) | 5367 (58.3) | | | | |
| Needs Support of Others | 4338 (47.1) | 1.916 (1.762-2.084) | <0.0001 | - | - |
| Does Not Need Support (ref) | 4864 (52.9) | | | | |
| **Health Status:** | | | | | |
| Poor health | 489 (5.3) | 1.929 (1.449-2.568) | <0.0001 | - | - |
| Fair health | 2167 (23.6) | 1.688 (1.328-2.146) | <0.0001 | 1.594 (1.199-2.119) | 0.0069 |

| | | | | | |
|---|---|---|---|---|---|
| Good health | 3930 (42.7) | 1.359 (1.076-1.716) | 0.7323 | - | - |
| Very good health | 2279 (24.8) | 1.123 (0.883-1.428) | <0.0001 | - | - |
| Excellent health (ref) | 337 (3.7) | | | | |
| Health limiting activity a little bit | 2718 (29.5) | 1.447 (1.314-1.592) | <0.0001 | 1.333 (1.185-1.498) | 0.0003 |
| Health limiting activity a lot | 1836 (20.0) | 1.421 (1.274-1.585) | 0.0016 | - | - |
| Health not limiting (ref) | 4648 (50.5) | | | | |
| Number of Comorbidities | $\bar{x}$ = 2.7, SD = 2.1 | 1.058 (1.037-1.080) | <0.0001 | - | - |
| **Healthcare Utilization:** | | | | | |
| Utilized More than 2 Providers | 4254 (46.2) | 1.483 (1.364-1.611) | <0.0001 | 1.270 (1.141-1.413) | <0.0001 |
| ≤ 2 Providers (ref) | 4948 (53.8) | | | | |
| Utilized More than 2 Locations for Primary Healthcare Services | 2317 (25.2) | 1.434 (1.319-1.558) | <0.0001 | - | - |
| ≤ 2 Locations (ref) | 6885 (74.8) | | | | |
| Visits PCP Every Few Years | 217 (2.4) | 1.514 (1.121-2.044) | <0.0001 | 2.057 (1.445-2.927) | <0.0001 |
| Visits PCP Once a Year | 1670 (18.4) | 0.770 (0.656-0.904) | 0.0318 | - | - |
| Visits PCP Every 6 Months | 2770 (30.5) | 0.558 (0.480-0.648) | <0.0001 | 0.917 (0.769-1.094) | <0.0001 |
| Visits PCP Every 2-5 Months | 3481 (38.4) | 0.719 (0.623-0.831) | <0.0001 | 0.928 (0.788-1.092) | <0.0001 |
| Every month (ref) | 937 (10.3) | | | | |

| | | | | | |
|---|---|---|---|---|---|
| Receive Most Care in Hospital/Urgent Care | 579 (6.4) | 1.615 (1.364-1.912) | <0.0001 | - | - |
| Other locations (ref) | 8528 (93.6) | | | | |
| Visited ED 1-2 Times in Last 12 Months | 2509 (27.3) | 1.497 (1.363-1.644) | 0.3380 | - | - |
| Visited ED 3 or More Times in Last 12 Months | 541 (5.9) | 2.519 (2.104-3.016) | <0.0001 | 1.339 (1.073-1.672) | 0.0107 |
| No visits (ref) | 6152 (66.9) | | | | |
| **Geography:** | | | | | |
| Live in Large City | 1372 (14.9) | 1.048 (0.908-1.209) | 0.2946 | - | - |
| Live in Suburb of a Large City | 3203 (34.8) | 0.900 (0.800-1.014) | 0.0020 | - | - |
| Live in Small City or Town | 2879 (31.3) | 1.061 (0.941-1.196) | 0.0915 | - | - |
| Rural (ref) | 1748 (19.0) | | | | |
| Live in Midwest | 2273 (24.7) | 1.035 (0.912-1.174) | 0.7050 | - | - |
| Live in South | 3546 (38.5) | 1.075 (0.957-1.208) | 0.4545 | - | - |
| Live in West | 1624 (17.7) | 1.090 (0.950-1.249) | 0.3661 | - | - |
| Northeast (ref) | 1759 (19.1) | | | | |

**Abbreviations:** *n*, number; CI, confidence interval; ref, referent; $\bar{x}$, mean; SD, standard deviation, PCP, Primary Care Provider; ED, Emergency department.

## DISCUSSION

The level of self-reported low medication adherence in this large sample of healthcare consumers from the general population, using a well-recognized standardized instrument, of 42% is alarmingly high, and is probably an underestimate. It is somewhat lower than the 52.7% seen with the same measure in an inner-city sample, which was associated with younger age.[21] Similarly, lower age was the strongest predictor of low adherence in our study, followed by socioeconomic status as it relates specifically to the ability to afford healthcare costs, frequent use of emergency room or urgent care centers for healthcare, and use of more providers - all associated with lower adherence rates. High adherence rates were associated with having a frequent ongoing relationship with a primary care provider.

A limitation of the study is its cross sectional nature. A prospective longitudinal study of a large general population sample, would allow for a determination of associated adverse health outcomes from low adherence over time. Some limitations of the study may suggest the low adherence estimates obtained may be an underestimate: A potential source of bias is that those who are less adherent, may be less likely to participate in online surveys. The study is focused on adherence in general, rather than specific conditions or medications. Since it is possible for a person to indicate adherence to one medication whilst being non-adherent to another, and reporting themselves as overall adherent, this could also suggest the present already very high estimates on low adherence may underestimate the true level of low adherence. The survey was administered in English language only, a Spanish language version may elicit more reporting of low-adherence for the Hispanic respondents. One additional limitation of the study was the restriction on survey length, which limited the ability to explore adherence by specific disorders,

and a deeper exploration of the patient's health status. Further, this is a comprehensive evaluation of the US population, and its application to other countries warrants further study.

One of the larger studies of low adherence in the U.S. is the Cohort Study of Medication Adherence among Older Adults (CoSMO), an investigation of antihypertensive medication adherence among 2,194 adults aged 65 years and older recruited from a managed care organization in Louisiana.[22] In this study, 14.1% of respondents self-reported reported low medication adherence using the Morisky Medication Adherence Scale (MMAS 8-item version).[12] Factors associated with low adherence included being younger (less than 75 years of age), being African-American, having a higher body mass index (BMI).[22] In a subsequent study of this cohort, a decline in adherence was predictive by the presence of depressive symptoms, being female, being married, and the level of stressful life events experienced.[23] Our rate of 42% is 3-fold higher than the CoSMO study, however, shorter enrolment time in healthcare plans is associated with higher levels of non-adherence.[6] Our higher rate may also be accounted for by the wider range of patients (i.e., not restricted to those with a singly condition) and the wider age distributions compared to the CoSMO sample. As noted in the CoSMO study, even among an older sample, younger age was associated with low adherence.[22] We found that younger age was the strongest independent factor associated with of low-adherence in the present study, consistent with our previous studies showing higher adherence with increasing age.[9,10] Age may also be related to more commonly having a continuous relationship with a provider, something that is not always seen with younger healthy individuals.

Low-adherence was observed uniformly across the country, without differentiation to geographic region, size of community, and respondents' health status and level of comorbidities. However, beyond age, certain demographic characteristics stand out as being significantly

independently associated with low adherence, notably being of Hispanic origin or African-American. This is after adjusting for income and other access and healthcare utilization factors. A recent study of income data for the US population from 1999-2004 showed that higher income was associated with greater longevity over time and differences in life expectancy were correlated with rates of smoking, obesity and positively correlated with exercise rates.[24] Furthermore, medical causes such as heart disease and cancer mortality are known to be higher in in individuals with lower socioeconomic status when compared to vehicle crashes, suicide and homicide. Could a lack of a consistent relationship with a provider, the inability to afford health costs or ease of being able to access healthcare and poor medication adherence lead to greater mortality from heart disease and cancer? Further exploration is warranted to determine the drivers of low adherence in these populations, so perhaps to be able to improve health outcomes in lower socioeconomic areas.

Although respondents' health status *per se* was not independently associated with low-adherence in our multivariate model, importantly the level of healthcare utilization was. Low-adherence was significantly and independently associated a high level of emergency room use. In this study it is not possible to tease out temporal causality, and it may be that these factors may be a consequence of low adherence, but also possible predictors, as the use of multiple providers may foster the possibility of miscommunications in health education and counselling, particularly with regard to medication use. Development of a centralized electronic medical record, independent of healthcare systems, that allows all providers a link to the same information source, could assist in improving the quality of healthcare delivery by reducing harms, improving communication between providers, thereby improving medication adherence.

In the present multivariate model, low-adherence is a phenomenon observed uniformly across the country, with no statistically significant differentiation with regard to geographic region, size of community, and respondents' health status and level of comorbidities. However, beyond age, certain demographic characteristics stand out as being significantly independently associated with low adherence, notably being of Hispanic origin or African-American. This is after adjusting for income and other access and healthcare utilization factors. Further research is warranted to determine the drivers of low adherence in these populations. Again, it may be that the quality and delivery processes for health education and counselling with regard to mediations may be deficit for ethnic minority patients.

## CONCLUSIONS

This study demonstrated a very high level of self-reported low medication adherence in the general population, reinforcing the WHO report of non-adherence as a significant public health problem. It is particularly evident that after adjusting for income and insurance status, medication adherence remains a significant issue for ethnic minorities, those who use multiple healthcare providers, and those who experience barriers to healthcare access in term of the ability to pay for healthcare and medications, and transportation issues. Patient education, counselling, and healthcare policy initiatives directed to addressing low medication adherence, should be priorities for research and interventions. One such step could be to focus healthcare resources towards how to engage patients in a meaningful, continuous, and quality patient-provider relationship, that is medication adherence-centric.

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**STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cross-sectional studies***

| Section/Topic | Item # | Recommendation | Reported on page # |
|---|---|---|---|
| **Title and abstract** | 1 | (*a*) Indicate the study's design with a commonly used term in the title or the abstract | 3, abstract |
| | | (*b*) Provide in the abstract an informative and balanced summary of what was done and what was found | 3 |
| **Introduction** | | | |
| Background/rationale | 2 | Explain the scientific background and rationale for the investigation being reported | 5-6 |
| Objectives | 3 | State specific objectives, including any prespecified hypotheses | 6 |
| **Methods** | | | |
| Study design | 4 | Present key elements of study design early in the paper | 6 |
| Setting | 5 | Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection | 7 |
| Participants | 6 | (*a*) Give the eligibility criteria, and the sources and methods of selection of participants | 7 |
| Variables | 7 | Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable | 7-9 |
| Data sources/ measurement | 8* | For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group | 7-9 |
| Bias | 9 | Describe any efforts to address potential sources of bias | 17 |
| Study size | 10 | Explain how the study size was arrived at | 7 |
| Quantitative variables | 11 | Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why | 7-9 |
| Statistical methods | 12 | (*a*) Describe all statistical methods, including those used to control for confounding | 9,12 |
| | | (*b*) Describe any methods used to examine subgroups and interactions | 12 |
| | | (*c*) Explain how missing data were addressed | n/a no missing data |
| | | (*d*) If applicable, describe analytical methods taking account of sampling strategy | n/a |
| | | (*e*) Describe any sensitivity analyses | n/a |
| **Results** | | | |

| | | | |
|---|---|---|---|
| Participants | 13* | (a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed | 7 |
| | | (b) Give reasons for non-participation at each stage | n/a |
| | | (c) Consider use of a flow diagram | n/a |
| Descriptive data | 14* | (a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders | 11 |
| | | (b) Indicate number of participants with missing data for each variable of interest | n/a no missing data |
| Outcome data | 15* | Report numbers of outcome events or summary measures | 12 |
| Main results | 16 | (*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included | 12 |
| | | (*b*) Report category boundaries when continuous variables were categorized | n/a |
| | | (*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period | n/a |
| Other analyses | 17 | Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses | 12-16 |
| **Discussion** | | | |
| Key results | 18 | Summarise key results with reference to study objectives | 17 |
| Limitations | 19 | Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias | 17 |
| Interpretation | 20 | Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence | 20 |
| Generalisability | 21 | Discuss the generalisability (external validity) of the study results | 17 |
| **Other information** | | | |
| Funding | 22 | Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based | 1-2 |

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

**Note:** An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.